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Review

Consensus report: Preventive measures for Crimean-Congo Hemorrhagic Fever during Eid-al-Adha festival

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ABSTRACT

Crimean-Congo hemorrhagic fever (CCHF) is endemic in Eurasian countries such as, Turkey, Pakistan, Afghanistan and Iran. CCHF virus is spread by the Hyalomma tick, which is found mainly on cattle and sheep. Muslim countries, in which these animals are sacrificed during Eid-Al-Adha, are among the countries where CCHF is endemic, and it has been observed that CCHF is associated with practices surrounding the Eid-ad-Adha festival. The dates for Eid-Al-Adha drift 10 days earlier in each year according to Georgian calendar. In previous years Eid-al-Adha occurred in autumn-winter months however in the next 10-15 years it will be take place in the summer months when CCHF is more prevalent. This may lead to a rise in the number of cases due to increased dissemination of CCHF virus with uncontrolled animal movements in and between countries. This consensus report focuses on the variable practices regarding animal handling in different regions and possible preventative measures to reduce the incidence of CCHF. Environmental hygiene and personal protection are essential parts of prevention. There is a need for international collaborative preparedness and response plans for prevention and management of CCHF during Eid-Al-Adha in countries where the disease is prevalent.

1. Introduction

Eid-al-Adha (the Muslim Festival of Sacrifice) occurs annually during the Hajj (annual pilgrimage to Mecca) and is an important Eid celebration for Muslims around the world. Animal sacrifices are performed during this festival in recognition of the willingness of Prophet Ibrahim (Abraham) to sacrifice his son Ismail for God's sake. Those who do not attend Hajj also sacrifice animals in their own countries. During these festivals, Muslims sacrifice animals such as cattle, sheep, goat, or share a camel. Generally Muslims slaughter animals by themselves, but a person who is not able to do so can appoint someone else to undertake the slaughter on their behalf.

The dates in the Islamic Calendar for Eid-Al-Adha are drifting 10 days earlier each year according to Georgian calendar. In the past Eid-al-Adha has occurred in the autumn – winter months but in the next 10-15 years the festival will occur in summer months when Crimean Congo Hemorrhagic Fever (CCHF) is more prevalent. This may cause increased number of cases with CCHF, due to inadequate knowledge about the disease, careless practices of slaughtering animals, and dissemination of CCHF virus (CCHFV) through uncontrolled animal movements in and between countries.

In 2015, although there are some regulations and policies for prevention of zoonotic diseases during slaughtering activities, there is no guideline or consensus report focusing for the prevention of CCHF during Eid-al-Adha. The goal of this consensus

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document is to summarize the relevant data, raise awareness of the risk of acquiring CCHFV during animal handling, and make recommendations for detection and prevention of CCHF, particularly during Eid-al-Adha and to identify future research priorities in this area.

We searched PubMed, ISI Citation Indexes from Jan 1, 1957, until June 15, 2015 without any language restrictions. Search strategy used included terms "hemorrhagic fever virus, Crimean–Congo [MeSH]", "hemorrhagic fever, Crimean [MeSH]", "Crimean–Congo hemorrhagic fever", "Crimean–Congo haemorrhagic fever", "Crimean–Congo", "Eid-al-Adha", "Eid-ul-Azha", "hajj" "pilgrimage", "epidemiology", "slaughtering" and "animal". References were imported into Endnote to be further analyzed. Further relevant articles were identified through cited references. Two authors (HL and MS) screened all abstracts of the articles for relevance of the topics for consensus. Article quality was evaluated using Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Strobe criteria.[1]

2. General overview of CCHF

Crimean-Congo hemorrhagic fever (CCHF) is caused by an arbovirus, which is in the Nairovirus genus of the family Bunyaviridae.[2] It can be transmitted to humans by ticks of *Hyalomma* spp. CCHF virus (CCHFV) may also be transmitted by contact with blood and other body fluids of viremic patients and animals. Its main hosts are domestic animals, such as cattle, sheep and goats and it has the potential to cause population – based outbreaks.[3] It is a life-threatening viral zoonosis with characterized by acute onset high fever and bleeding with thrombocytopenia.[2,4] The CCHF-induced mortality rate differs from country to country ranging from 2% to 80%, with early diagnosis and supportive management of disease essential.[3] Since there is no specific proven antiviral treatment for CCHF,[5] supportive therapy is essential and includes replacing blood components, fluids and electrolyte management and maintaining organ functions.[6]

2.1. Geographic distribution of CCHF

The distribution of CCHFV covers the greatest geographic range of any tick-borne virus. The occurrence of CCHF correlates with the dissemination of the genus *Hyalomma marginatum*, which is the principal vector of the disease.[7] CCHF is endemic in parts of Africa, the Middle East, Asia and southeastern Europe.[2,8] The virus is present in over 30 countries in Africa, Asia, the Middle East and southeastern Europe (Figure 1). Since 2000, there have been outbreaks and an increasing number of case reports and outbreaks in Turkey, Kosovo, Albania, Bulgaria, Greece, Iran, Pakistan, Afghanistan, the Russian Federation, Kazakhstan, Tajikistan, Georgia, Mauritania, Kenya, Senegal and South Africa.[3,9,10]

2.2. CCHF in veterinary health

Animals play a critical role in the life cycle of CCHFV, with amplification of the virus before transmission to humans by ticks. Most animals infected with CCHFV do not display signs of clinical disease and CCHFV infection has been detected in a wide range of wild and domestic mammals.[11,12] Viremia in mammals can last for up to two weeks with no clinical signs,[13] and different serological prevalence rates have been reported in livestock in various countries (Egypt, Iran, Kosova, Niger, Saudi Arabia, Sudan, Turkey) i.e. 0.6% to 79% in cattle, 3.7% to 85.7% in sheep and 3.2% to 66.6% in goats.[14–24]

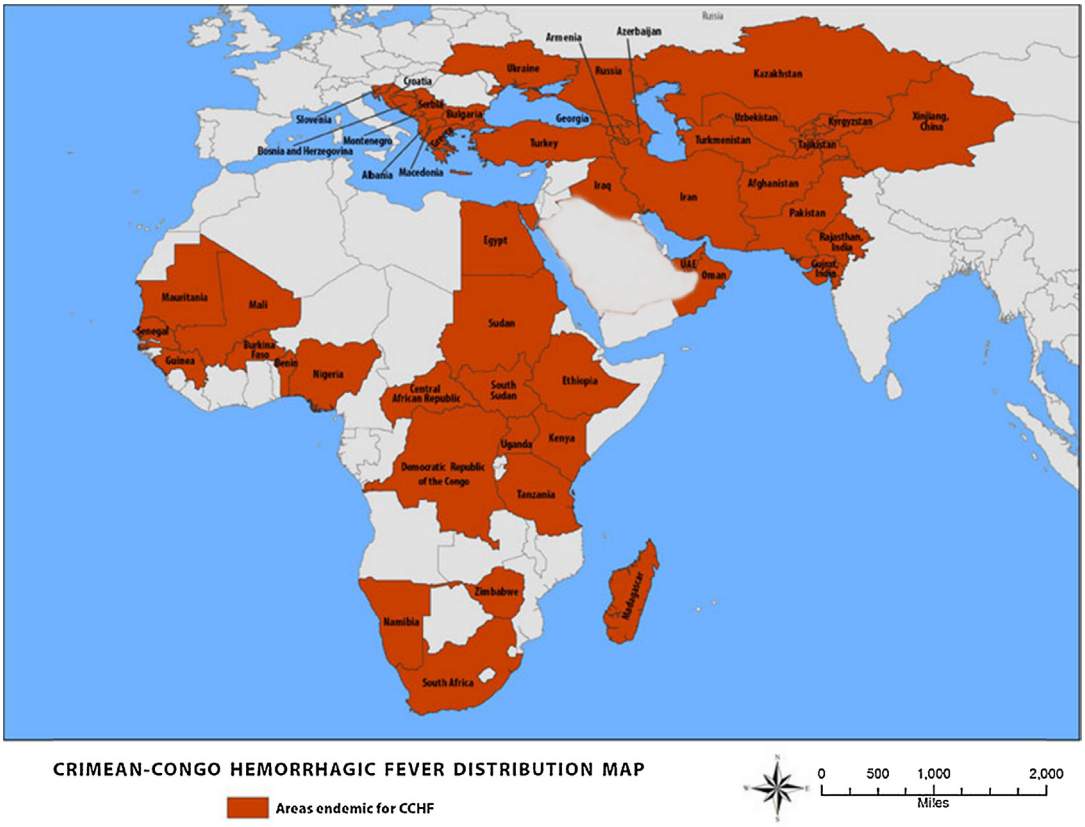

Figure 1. Endemic areas of Crimean-Congo Hemorrhagic Fever in the world.
(Updated from Center for Disease Control and Prevention http://www.cdc.gov/vhf/crimean-congo/resources/distribution-map.html).

2.3. Animal to human transmission of CCHFV

CCHFV can be transmitted through blood to people in high-risk occupations including those dealing with animal and animal products,[25,26] and an increased number of CCHF cases has been reported after Eid-al-Adha in Pakistan.[27,28] Based on official records of the Ministry of Health Turkey, 61.7% of human CCHF cases in Turkey between 2004 and 2007 reported having contact with animals. Of those cases, 9.9% (n = 165) had direct contact with animal blood, other body fluids or animal tissue.[29] In Iran occupations with close contact with animals and/or animal blood or tissues have been reported to have higher CCHF seroprevalence rates.[30] The seroprevalence of CCHF has been shown to be 10.0% - 13.6% in high-risk human populations.[31–33] History of tick bite and/or contact, having a profession in animal husbandry or farming and living in a rural area were reported to be the most important risk factors for CCHF exposure.[31–36]

2.4. Animal movements

CCHF continues to emerge in various parts of the world. The environment, tick density, migration or transportation of tick-infested birds, number of host vertebrate animals, movements of livestock, climatic and agricultural changes have all played major roles in the spread of CCHF virus into new areas.[10,37–40] The main cause of its dispersion through Eastern Europe was thought to be movement of wild and domestic animals carrying infected ticks.[41] Trans-border movements of ruminants for religious festivals, breeding, slaughtering or transhumance may also play a role in dissemination of the virus between neighboring countries.[42,43] The eastern region of Turkey has been an important crossing area of uncontrolled animal movements, and this uncontrolled trade of livestock on the borders between Turkey, Iran and Iraq might facilitate the spread of the viruses west or east.[43] Imported strains may serve as a biological mixer for CCHF strains and could change the gene pools of the endemic regions. It has been shown that CCHFV in Iran has multiple origins with strong geographical relationships between virus strains. Moreover, phylogenetic analysis revealed links between distant geographical locations, which may have originated from livestock trade or from long-distance carriage of virus by infected ticks during bird migration.[30,44]

3. Country specific experience and regulations for slaughtering animals during Eid-al-Adha

3.1. Kingdom of Saudi Arabia (KSA)

The Hajj is the largest annual recurring mass gathering event in the world. Muslim pilgrims from more than 180 countries attend the event every year in KSA. The Government allocates huge resources for alert and response planning based on a multidisciplinary group of experts from various government sectors.[45] Annual planning and proactive surveillance for communicable diseases, response and action are carefully monitored,[45] and the Supreme Hajj Committee is responsible for the coordination and development of the annual Hajj plan and setting the recommendations for developing Hajj facilities.[46] The Hajj Preventive Medicine Committee is responsible for the control of ports of entry for all pilgrims and confirms compliance with Hajj requirements. There is ongoing surveillance for emerging and other viral diseases (including CCHF) using a variety of systems[46] Utilization of the Healthcare Electronic Surveillance Network (HESN), a web-based electronic health solution, is being implemented and includes communicable disease case management, outbreak management, and immunization management.[46]

Active surveillance for communicable diseases by the host country has been able to clearly document the threat of communicable diseases spread inside KSA and abroad from such an event. A few cases of CCHF were reported among abattoir workers in Makkah, KSA in 1990. The source of the infection was thought to be ticks on imported sheep.[47] Special slaughterhouses are made available for the pilgrims to utilize for the rituals during the Hajj. Continued surveillance and vigilance is a paramount factor for the detection and prevention of CCHF during the Hajj.

3.2. Iran

Viral Hemorrhagic Fever (VHF) surveillance system protocols in Iran indicate that the majority of slaughtering is done in industrial slaughterhouses, using appropriate personal protective equipment (PPE) including gloves, glasses, and plastic gowns. The regulations are highlighted especially in high-risk regions such as Southeastern Iran and near the Afghanistan and Pakistan borders. In Eid-al-Adha there is an arrangement by the municipalities of the capital and large cities in coordination with Iran Veterinary Organization (IVO) for special temporary centers for slaughtering based on standard protocols. Despite all the arrangements sporadic unregulated slaughtering without using appropriate PPE still occurs in villages or small towns.

The number of CCHF confirmed cases before and after the Eid-Al-Adha do show not significant differences,[48] suggesting adherence to IVO protocols. All livestock transportation between different parts of Iran is also under strict supervision of IVO, who also supervise the utilization of insecticides for livestock. The possibility of illegal livestock movement from eastern neighboring countries to Iran remains a serious concern for the surveillance system of Iran.

3.3. Pakistan

In Pakistan, both small and large cattle owners in urban, peri-urban and rural areas maintain animal husbandry. A routine supply of livestock for consumption of meat is provided at daily cattle markets usually located near the official slaughterhouses. As per official legislation, animals should be slaughtered at designated facilities.[49] It is required that slaughterhouses have veterinarians present to ensure that animals are healthy. Meat, fat, animal hides and other body parts separated from the slaughtered animals are all sold at the site and transported to shops by meat suppliers.

During Eid-al-Adha however, the pattern of animal slaughter changes; in accordance with religious beliefs animals are sacrificed and often, individuals become involved in this activity. The sale of animals is less regulated; there is an increased movement of animals from endemic areas to urban centers, purchases are made both from cattle markets and local vendors who bring animals from rural areas to commercial and residential areas of cities. Hence, it is common for families to purchase cattle, goat or sheep several weeks in advance of Eid, to maintain the animal for sacrifice on Eid-al-Adha. This leads to an increased exposure of the general public to viremic animals.

During Eid-al-Adha it is also more common for non-professional butchers to free-lance, going from house to house, to sacrifice animals, as people find it more convenient to have the sacrifice performed at home. As such, the slaughter is commonly performed on the road-side outside homes, in public. The local authorities do not to regulate health checks on animals purchased by individuals, and generally little is done to reduce tick infection in cattle.

Recent increases in CCHF cases during Eid-al-Adha has been observed in Pakistan.[27] Generally, there has been an increase in CCHF positive cases since 2009; in the past 5 years (2009-2014),

the Aga Khan University Hospital tested 524 specimens for CCHFV of which 91 specimens were found to be positive. The yearly positivity rate for CCHFV has been increasing with a similar bi-annual peak to that observed previously, with largest numbers of CCHFV positive specimens received during October – November of each year.[50] When the trends of CCHFV positive cases were compared, it was shown in 2013 that 58%, and in 2014, that 62% of CCHFV positive cases were found around the Eid-al-Adha season. These data suggest an association of CCHFV virus infection with this period and the increased rates of infection could be attributed to the changing patterns of animal movements, handling, butchery and animal exposure during Eid-al-Adha.[51]

3.4. Turkey

During Eid-al-Adha approximately 2 million small animals and 750 thousand cattle are slaughtered every year in Turkey. This accounts for about 25% of all animals slaughtered annually. Eid-al-Adha related seasonal protocols for livestock animal movements and follow-up regional marketing and sacrificing are regulated by governmental legislations. The government updated the food chain and agricultural related laws and regulations in order to harmonize with regulations of European Union in 2011.[52,53] Under normal circumstances, animals to be slaughtered during Eid-al-Adha are not legally allowed for trade without a veterinary health certificate, food chain information and animal identification. Animals to be slaughtered are sold in markets under the supervision of the official or authorized veterinarians. However, activities of animal shipping, marketing and slaughtering are conducted beyond the control of veterinarians, and can pose a significant risk to human health. In Turkey, during the Eid Al-Adha the most hygienic way of slaughter and subsequent manipulation of meat are described repeatedly by the Ministry of Food, Agriculture and Livestock in terms of either visual media or official handouts before the feast. While the government and local authorities promote animal slaughter in restricted areas under supervision by authorized municipality veterinarians, some people prefer slaughtering themselves in un-controlled public areas such as roadsides or backyards, which are not suitably designed for this purpose.

The widespread presence of Hyalomma tick species in Turkey and intensive animal movements between regions have particular importance in the epidemiology of CCHF. As such, the virus tends to spill into non-endemic regions of Turkey by un-controlled movement of livestock animals infested with CCHFV-carrying *Hyalomma* ticks. CCHFV-infected tick bites can also occur in marketing and slaughtering areas when they encounter tick-carrying livestock.

Local livestock market areas transiently established during the Eid al-Adha play an important role in the transmission of various infectious agents (including CCHF), both in animals exhibited and also humans. This is particularly the case in in metropolitan areas where excessive numbers of market places contain large amount of livestock animals. Within the framework of the legislation, it is mandatory to use these market places, however, in some periods such as Eid-al-Adha, marketing of animals is carried out in small-scale settlements in which veterinarians are not available. Thus, routine ectoparasite control and acaricide treatment of animals before and during marketing, thought to be effective measurements in protecting human health are not undertaken.

4. Prevention of CCHF

The main preventive measures for CCHF are the avoidance of tick bites, use of PPE and control of CCHF in animals by using acaricides in livestock production facilities (Figure 2).

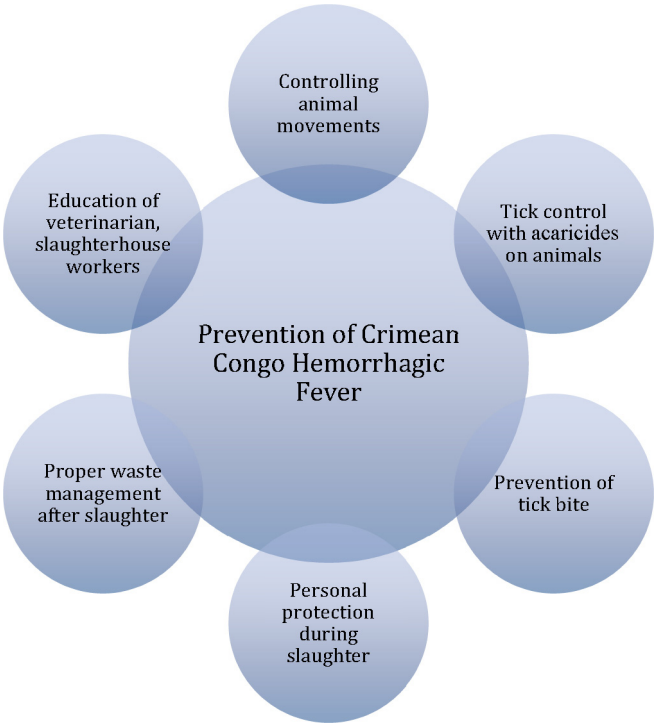

Figure 2. Key components of prevention of Crimean-Congo Hemorrhagic Fever.

4.1. Controlling CCHF in animals and ticks

The control and prevention of CCHF in the animal host and tick vector is difficult. This is because the infection in animals is asymptomatic and ticks are widespread and abundant in endemic regions. Acaricides are useful for tick control when applied prior to animal slaughter, and a 14-day period of quarantine prior to slaughter has also been used.[54] Presently there are no vaccines available for animal protection.

4.2. Controlling animal movements

Uncontrolled livestock animal movements between endemic countries (transborder transmission) should be restricted by official regulations and penalties organized by local authorities. This will help to stop spreading new antigenic (or genetic) variants of the virus between countries. Check points for animals and related document controls should be organized by veterinary and treasury officers synchronously during the transport of animals. Acaricides can also be used on animals before export and effective communication between countries should prevent uncontrolled animal movements.

4.3. Reducing the risk of infection in people

The key to protecting people from infection with CCHF is raising awareness and education, targeted at high-risk groups and endemic regions. A vaccine has been developed in Eastern Europe and is used on a small scale, but at present there is no proven and safe vaccine available.[55]

4.3.1. Reducing the risk of tick-to-human transmission

Except during the egg stage, all other biological stages of ticks feed on blood from humans. In general they do not show host specificity. Depending on the geographical location and species type ticks are generally active between April and September in North Hemisphere, accounting for CCHF disease during this period.

Agricultural workers and others working with animals including those who live in rural endemic areas should wear light coloured protective clothing (long sleeves and long trousers) that allows rapid identification of ticks. Insect repellants containing DEET can also be used and skin and clothing regularly examined for the presence of ticks. Ideally people should try to avoid exposure to habitats and seasons where ticks are most abundant.[55]

After a tick attaches, it should be removed using fine-tipped tweezers as soon as possible and the bite area and hands should be thoroughly washed with soap and water and an antiseptic applied to the bite site. After visiting tick-infested areas, if there is unexplained illness with fever, people should seek medical advice and inform healthcare workers about travel history to areas where tick-borne diseases are common.

4.3.2. Reducing the risk of animal-to-human transmission

Animals play a crucial role in the life cycle of ticks and, therefore, in the transmission and amplification of the virus. Viremia or antibodies have been detected in a broad range of wild and domestic mammals. Animals originating from endemic areas may be treated with pesticides two weeks before slaughter in order to inhibit possible tick infestation. Gloves and personal protective equipment must be worn by people handling animals in endemic areas. Necessary protective measures must also be taken when in contact with animal carcasses and body fluids of animals. The outer side of the hide must never touch the surface of animal body and internal organs and the slaughterers should not handle the hide without gloves. People must be aware of the risks of disease transmission handle the hide of animals without gloves. The waste and blood of animals should not be disposed into streams and watercourses, but methods such as rendering, landfill, composting and anaerobic digestion should be adopted.

4.3.3. Reducing the risk of human-to-human transmission

Healthcare personnel are at risk from occupational infections during the provision of care to CCHF patients; the first such cases were described in Pakistan and later reported from many Eurasian countries.[56,57] Isolated imported cases of CCHF or outbreaks in countries lacking CCHF experience present particular infection control challenges, increased risk to healthcare workers (HCWs), and are associated with increased mortality.[58] Critical care management, associated with increased invasive procedures and the potential for aerosolization in highly viremic patients pose additional challenges.[59] Key to mitigating this risk is enhanced awareness and early recognition of CCHF that allows HCWs to adopt the necessary PPE and infection prevention and control practices.

4.3.4. Management of post-exposure injuries

There has been no approved antiviral treatment and prophylaxis for CCHF. Following exposure to a potentially infected fluid, the affected site should be immediately washed with soap and water. The incident should be reported to public health authorities. As a precaution the affected case should be observed for 14 days with daily temperature and monitoring sign and symptoms of CCHF. Ribavirin prophylaxis for those with a high-risk exposure to CCHFV may be beneficial, however ribavirin use as post-exposure prophylaxis remains controversial due to the limited data available.[60,61]

5. Prevention of CCHF during Eid-al-Adha

As the disease is asymptomatic in animals, control and prevention is difficult, especially during Eid-Al-Adha when animal trade and movements are uncontrolled through in and between countries. Priority control measures include strict animal movement regulation where disease is endemic and tick control, supported by a surveillance program. Enhanced checking of animals for tick infections should be conducted and decontamination of animals using insecticides performed.[10] Animals could be treated with an acaricides to prevent infestation by the tick 14 days before animals are distributed to sales centers. However due to the high rates of animal movements before Eid-Al-Adha this regulation is very difficult to enforce.[62] The widespread free-ranging husbandry that occurs in smallholder farms in resource-limited countries presents another important barrier for implementing strict biosecurity measures.

All activities comprising obligatory handling and/or contact with blood and tissues of sacrificed animals during Eid-al-Adha festival should be considered having potential risks for virus spillover between infected animal and humans. Therefore, on the occasion of Eid-al-Adha festival, regulations must be implemented in order to reduce possible occurrences and to protect public health (Table 1). Instead of backyard animal slaughtering practices, it should only be done in abattoirs or restricted sites for slaughter must be created.

Environmental hygiene will consist of preventing pests' (rodents, insects, birds) and pets' access to slaughtering area and solid and liquid waste disposal. The waste and unused viscera should be disposed as described above. Abattoir workers, local butchers and people should be trained about basic precautions to use and the most appropriate hygienic ways in sacrificing practice, handling carcasses and animal tissues.

Public health officials should encourage slaughterhouse staff including veterinarians and technicians at abattoirs to take precautions against accidental exposure. Personal protection measurements should be expanded and safety precautions regarding handling of animals should be in place such as hand washing. Any suspicious contact especially contact with blood or blood products should be monitored carefully. Large numbers of ticks attached the animal's skin, especially around the ears, base of the tail, neck and less hairy other body parts (e.g. armpits and inguinal regions) can easily be seen during handling of the body after sacrifice.

During skinning and subsequent tanning of the hides, ticks can bite humans. Routinely after animal slaughter, skinning starts 5 to any blood 10 minutes blood drainage. After the skinning stage,

Table 1
Recommended practices for prevention of Crimean-Congo Hemorrhagic Fever during care and slaughter of animals

Animal care personnel, abattoir staff
- Should be trained about animal care, animal welfare and slaughtering.
- Must take precautions against accidental exposure to blood and fluids of animals.
- Should take precautions to prevent serious injury to themselves and others.
- Should wash their hands.
- Should wear gloves and other protective clothing during animal slaughter and handling of animals, their tissues or body fluids.
- Should not handle the hide without gloves.
- Prevent tick bites during skinning and tanning the hides.
- Inspect their body each day to check for ticks and remove the attached ticks on skin with fine-tipped tweezers. Showering may help wash off unattached ticks.
  - ○ Don't touch or crush the tick with your bare hands.
  - ○ Don't try to remove the tick with your fingers.

Slaughtering
- Avoid backyard animal slaughtering practice.
- Slaughtering should be done in abattoirs or restricted places.
- Slaughtered animals are drained of blood as soon as possible.
- Pests (rodents, insects, birds) and pets should be controlled to prevent their access to slaughtering area.
- Tanning of the hide using salt should be done at a distance from the carcasses.
- The waste and blood of animals should not be disposed into streams and watercourses and safe methods adopted.

attached ticks on the hide are not able to blood feed and start to seek new hosts. Therefore, tanning of the hide using salt should be done at a distance from the carcasses. All these precautions will also help to reduce occurrence of all infections using similar transmission modes between ticks, livestock animals and humans such as Lyme disease, borreliosis, human anaplasmosis, babesiosis, Rocky Mountain Spotted Fever, Erlichiosis, tularemia, and rickettsiosis.

The training of public and animal health professionals and policy makers is crucial. Education and information on prevention of CCHF should also be targeted at those involved in slaughtering and handling of animals. In addition to formal courses, the approach involves placing advertisements on social media platform, short movies on TV, running ads on television, radio, billboards, magazines, and newspapers before and during Eid-Al-Adha.

6. Conclusion

This review emphasizes potential risk factors responsible for CCHFV transmission from animals during slaughter associated with Eid-al-Adha in Muslim countries. It identifies the traditional celebrations and/or behaviors associated with Eid-al-Adha; starting from purchasing of sacrificial animals to slaughtering practices that play an important role for virus transmission.

In developing countries the control of zoonotic diseases is generally managed by vertical programs, under different sections or ministries. To make preparedness and response plans for Eid-Al-Adha in Muslim countries at risk of CCHF, coordination and closer integration between ministries of health, agriculture, veterinary and working with intergovernmental organizations such as Food and Agriculture Organization (FAO), World Health Organization (WHO) and World Organization for Animal Health (OIE) should be established. This One Health approach is pivotal for implementing these policies for effective surveillance, control and management of CCHF with encouraging and fostering collaboration among veterinary researchers, infectious disease physicians, microbiologists, public health researchers, and ecologists. Also funding agencies should support knowledge translation from developed countries to resource-limited countries.

Governments should devote adequate resources to preventing and controlling of CCHF. It is recommended that local authorities in each CCHF endemic country take measures to practice vector control and reduce exposure to the virus via contact with of humans with blood and/or fresh meat of sacrificed animals. Informative campaigns can be introduced to the people in the most understandable way in terms of verbal and visual media organizations weeks before the festival. Collaborative effort between countries where CCHF is endemic is required, including setting up an international network for sharing expertise, knowledge and surveillance data and improvement of the diagnostic capacity.

Further studies are warranted to determine the causal relationship between the environmental, ecological and climatic factors that are drivers for CCHF. Vector control measures are of limited success in control of CCHF and there is no effective vaccine for use in humans and animals, making this a high priority area for future research. Understanding tick-CCHFV interactions may also provide new targets for blocking the transmission of CCHFV and Studies are needed to determine the potential impact of biological controls for reducing tick density. The current evidence gap in diagnosis and treatment of CCHF may be addressed through research, including the development of new diagnostic tools, including point-of-care diagnostic tests that can be incorporated into control and surveillance programs. A therapeutic agent for the treatment of CCHF is urgently required and clinical research should focus on antiviral drugs such as ribavirin and favipiravir, and immune-based therapeutic options.

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